



**UNIVERSITY OF MAINE AT FARMINGTON
COLLEGE OF EDUCATION, HEALTH AND REHABILITATION**

LESSON PLAN FORMAT

Teacher's Name: Sara Turner **Lesson #: 4** **Facet:** Explanation and Interpretation

Grade Level: 9-11 **Numbers of Days:** 3-4

Topic: Imaginary and complex numbers

PART I:

Objectives

Students will understand that the quadratic equation can result in complex numbers.

Students will know equation, variable, coefficient, constant, distribute, roots, parabola, quadratic, factoring ax^2+bx+c , quadratic formula, order of operations, trajectory, profit, complex number, imaginary number

Students will be able to derive a complex number from the quadratic equation and represent a complex number in an equation.

Product: Slideshow or Podcast

Maine Learning Results (MLR) or Common Core State Standards (CCSS) or Next Generation Science Standards (NGSS) Alignment

Common Core State Standards

Content Area: Algebra

Grade Level: High school

Domain: Reasoning with Equations and Inequalities

Cluster: Solve equations and inequalities in one variable

Standard 4: Solve quadratic equations and in one variable

Rationale: The students will be introduced to complex numbers and will understand how they are used in algebra and with quadratic equations.

Assessments

Formative (Assessment for Learning)

Section I – checking for understanding strategy during instruction

Students will take part in exploring graphs to work with a partner to identify graphs that have imaginary roots. The teacher will also facilitate slap it to give students a fun way of practicing recognizing complex numbers.

Section II – timely feedback for products (self, peer, teacher)

Based on student responses from exploring graphs, and their in class work, the teacher will be able to assess how well students are understanding and give feedback to the students. Students will also communicate with the teacher to ensure that they are fully grasping the idea of imaginary numbers.

Summative (Assessment of Learning):

Students will work either alone or with a partner to create a podcast, or a slideshow, to explain complex numbers, how they are derived, what their purpose is, how we represent them in an equation and their rules in an equation.

Integration

Technology (SAMR):

The slideshow or podcast that the students will be creating is at the augmentation level. They are at this level because a slide show allows for an automated presentation and a podcast allows students to record their thoughts and ideas on complex numbers.

Content Areas:

History: The teacher will give a background of where complex numbers come from and how they were first developed.

Groupings

Section I - Graphic Organizer & Cooperative Learning used during instruction

Students will fill out a frayer model to keep track what imaginary numbers are and the rules for solving equations containing complex numbers. The teacher will ask questions about complex numbers and students will take part in stand up, hand up, pair up, to further discuss and understand complex numbers.

Section II – Groups and Roles for Product

Students will work either alone or with a partner to create a podcast, or a slideshow, to explain complex numbers, how they are derived, what their purpose is, how we represent them in an equation and their rules in an equation.

Differentiated Instruction

MI Strategies

Verbal: Students will create frayer models to keep track of new ideas about complex numbers.

Logic: Students will need to think about what makes a number imaginary and how to distinguish them.

Visual: Students will be able to see graphs to help them identify imaginary roots, and what that means for the graph

Kinesthetic: Students will play slap it to help students identify what is and is not an imaginary number.

Intrapersonal: Students will reflect on themselves and how they feel they are understanding complex numbers.

Interpersonal: Students will take part in stand up, hand up, pair up, to work with others to create a deep understanding of complex numbers.

Modifications/Accommodations

From IEP's (Individual Education Plan), 504's, ELLIDEP (English Language Learning Instructional Delivery Education Plan) I will review student's IEP, 504 or ELLIDEP and make appropriate modifications and accommodations.

Plan for accommodating absent students:

If a student is absent at any point during this lesson, it is the students responsibility to check the teachers online website for what was discussed in class. If the student is absent on a day when the slideshow and podcast presentation is introduced the student must check the teachers online website and speak to the teacher about the presentation as well as check in with their partners. If a student misses more than one class during this lesson it is the students responsibility to check in with the teacher to ensure that they are understanding the material.

Extensions

Technology (SAMR): Gifted Students:

If students create a slideshow they must incorporate multiple kinds of media into their presentation to bring it to the modification level. If students create a podcast they must upload it to the specified online sharing website to share their thoughts and ideas.

Materials, Resources and Technology

- Projector
- Graphing calculator
- Textbooks
- Worksheets
- Handout- slideshow and podcast instructions
- Different colored markers
- laptops for students
- Graphic organizer
- Hook blank paper
- Fly Swatters

Source for Lesson Plan and Research

<https://docs.google.com/presentation/d/1VKiXDGVKgiAJtBJYYTkgtl-RMbVsE-PyuDRu10KifHk/edit#slide=id.p> Website to graphic organizer

http://www.ode.state.or.us/opportunities/grants/nclb/title_iii/5cooperative-learning-strategies.pdf Different cooperative learning strategies for teachers to use to help students.

<https://docs.google.com/document/d/1ppzvFz42AZ9bhUDjGLIFeAJWObrlrO-MIGap0wLD1wM/edit> Checking for understanding worksheet

<http://www.math.com/school/glossary/glossindex.html> Website for mathematical vocabulary

<http://www.themathpage.com/alg/complex-numbers.htm> Information and help with complex numbers.

<http://www.cut-the-knot.org/arithmetic/algebra/HistoricalRemarks.shtml> Brief history of complex numbers

<http://www.purplemath.com/modules/complex.htm> Help with complex numbers

<https://www.youtube.com/watch?v=4lnr8THgL5k> Starting hook video

<https://sites.google.com/a/fsh.echalk.com/google-apps-in-fshisd/google-presentations-video-tutorials> Tutorial for google presentation

<http://www.readingrockets.org/article/creating-podcasts-your-students> some suggestions for creating a podcast

<http://www.mathwarehouse.com/sheets/algebra-2/complex-numbers/> - Site where homework assignments were found.

<http://malini-math.blogspot.com/2009/10/real-life-applications-of-imaginary.html> Real world application of complex numbers.

PART II:

Teaching and Learning Sequence (Describe the teaching and learning process using all of the information from part I of the lesson plan) *Take all the components and synthesize into a script of what you are doing as the teacher and what the learners are doing throughout the lesson. Need to use all the WHERETO's. (1-2 pages)*

In the classroom, desks will be arranged in three rows of two facing the whiteboard. This will allow students to work with a partner easily when needed, and will also make it easy for the teacher to check in individually with students. The teacher's desk will be placed at the back of the room to maximize privacy for students needing extra help, while also allowing the teacher to watch over all students.

Agenda (include days and times)

Day One:

- 1) Hook (10 minutes)
- 2) Introduction to complex numbers (45 minutes)
- 3) Work on filling out frayer model with handout (stand up, hand up, pair up) (20 minutes)
- 4) Wrap up/homework (5 minutes)

Assignment: Finish frayer model and worksheet

Day Two:

- 1) Brief history of complex numbers (10 minutes)
- 2) Review of complex numbers and real world applications (15 minutes)
- 3) Group work- Exploring Graphing (20 minutes)
- 4) Introduction to project (30 minutes)
- 5) Wrap/homework (5 minutes)

Assignment: Practice work sheet

Day Three:

- 1) Go over homework (10 minutes)
- 2) Slap it (35 minutes)
- 3) Project work time (35 minutes)

Assignment: Work on project

Day Four:

- 1) Meet with group (5 minutes)
- 2) Presentations (60 minutes)
- 3) Teacher feedback (10 minutes)
- 4) Final wrap up of unit (5 minutes)

Teaching and Learning Sequence (Include all hyperlinks of the above URL's in this section.)

Students will understand that the quadratic equation can give complex numbers. Complex numbers show up frequently in mathematics as well as in the real world. *4: Solve quadratic equations and in one variable. b: Solve quadratic equations by inspection (e.g., for $x^2=49$), taking square roots, completing the square, the quadratic formula and factoring, as appropriate to the initial form of the equation. Recognize when the quadratic formula gives complex solutions and write them as $a+bi$ for real numbers a and b .*

The teacher will play the students a short [video](#) on imagination to get the students thinking about imagination. The teacher will give the students some colored pencils as well as a blank piece of paper and tell them to let their imagination run wild. This will allow students to be in the right state of mind to learn about imaginary or complex numbers.

Where, Why, What, Hook Tailors: *Visual, Interpersonal, Kinesthetic, naturalist*

The teacher will ask students if they know of or have heard of complex numbers. The teacher will go over any [vocabulary](#) that students need to know. The teacher will give an introduction to complex numbers, how they are represented in equations, the rules that they follow, and what they mean. The teacher will pass out Frayer model for the students to fill out to keep track of rules for complex numbers. The teacher will use [stand up, hand up, pair up](#) to put students into groups to work on the [handouts](#). The teacher will discuss real world applications with the students and how they are used in [physics](#) and other areas. Students will work on [exploring graphing](#) to help further their understanding on how complex numbers are used in equations. Students will also get to play slap it as a fun away to review complex numbers.

Equip, Explore, Rethink, Tailors: *Visual, Verbal, Logical, Kinesthetic, intrapersonal, interpersonal*

Students will be able to identify complex numbers and solve equations that include complex numbers. The students will be able to work alone or with a partner to create either a [google presentation](#) or a [podcast](#) to explain their

knowledge of complex numbers. Students will need to be able to explain what a complex number is, how they are represented and the various rules they follow in an equation. The teacher will provide extensive details on [complex numbers](#) so students have the information they need to do the presentation. The teacher will also provide [resources](#) for students to help them remember rules for complex numbers. The students will present their projects and the teacher will give them feedback from their presentation. If the students do not like their grade they can discuss with the teacher what they can do to try to raise their grade. Students will also reflect on how they think they did on their presentations, if they would do anything different and if they worked with a partner how well they worked together.

Experience, Revise, Refine, Tailors: *Visual, Verbal, Logical, Interpersonal, Intrapersonal*

The teacher will have a rubric for the student's presentation. The teacher will fill out a rubric while the students are presenting and will give students feedback with the rubric by the end of the class period. Students will be graded on how well made their product is. Also if the students talked about what complex numbers are, how they are represented, and their rules in equations. This lesson is the last lesson of the unit so this assignment will connect to previous units and information learned and will be revisited in future lessons.

Evaluate, Tailors: *Verbal, Logical, Visual, Interpersonal*

Teacher Content Notes

Vocabulary students will know:

- Complex number- A complex number is a number that can be expressed in the form $a + bi$, where a and b are real numbers and i is the imaginary unit
- Imaginary number- An imaginary number is a complex number that can be written as a real number multiplied by the imaginary unit i

The teacher will start by writing an example such as $\sqrt{-4}$ and ask students what is wrong with that. The teacher will discuss with students how previously this has been impossible for them because they have been told that you cannot take the square root of a negative number. The teacher will give the example $x^2 + 1 = 0$ and ask students how they would solve for x . The teacher will introduce complex numbers and explain to students that complex numbers, represented by the letter i . The teacher will explain to students that the letter i in an equation stands for -1 . The teacher will go over the rules that complex numbers follow in equations, such as how to add subtract multiply, and divide complex numbers. The teacher will explain to the students that complex numbers follow all the same rules that a normal variable would, however when computing, it is treated as a number. For example if the teacher puts up the equation $(3i) \cdot (4i) = 0$ the teacher will ask students to simplify, then solve, getting rid of i . The teacher will pass out a T-chart and worksheet to each student. The teacher will have the students do stand up, hand up, pair up to see how they are feeling about complex numbers. Based on this the teacher will have students work in partners or small groups to fill out the T-chart and worksheet. For homework the students will finish both of these papers. The teacher will give a brief history of complex numbers, who discovered them, how and why. The teacher will review complex numbers and answer any questions that the students have about how they work. The students will have a work sheet of example/non-example to further help them understand. The teacher will then introduce the project to the students, hand out rubrics and instructions and let them know what is expected of them for project. For homework the students will have one more practice worksheet to be sure they are understanding the concept. Students will also need to choose which product they would like to create and if they will work alone or with a partner. The teacher will brief go over homework and answer any questions students still have. The teacher will facilitate a game of slap it to help students identify complex numbers in equations and how they are represented. The teacher will then allow students the rest of class to work on their projects. The teacher will be available for any help that the students need. For homework the students will need to finish their projects and be ready to present during the next class. The teacher will allow students five minutes to meet with their group to prepare for their presentation. As the students present their projects the teacher will be assessing them and will provide feedback at the end of class for the students. Any students who do not like their grade may discuss with the teacher what can be done for a better grade. The students will also take a survey about their project, how they think they did, and if they worked with a partner how well they worked together. The students will be made aware that complex numbers will be showing back up in future lessons.

Handouts

- Homework assignment/ worksheet
- Frayer model
- Exploring graphing
- Slap it numbers
- Project check list

Maine Common Core Teaching Standards for Initial Teacher Certification and Rationale

Standard 1 – Learner Development. The teacher understands how learners grow and develop, recognizing that patterns of learning and development vary individually within and across the cognitive, linguistic, social, emotional, and physical areas, and designs and implements developmentally appropriate and challenging learning experiences.

Learning Styles

Clipboard: The teacher will have a website that has the class calendar on it that gives a brief overview of what was done in class. The any handouts given will be linked to the site as well as all homework assignments listed. Any and all assignment expectations or rubrics will be posted as well.

Microscope: Students will take part in daily in class practice giving them a chance for a deeper understanding of the material. This will also allow students to really have to analyze a new concept that they are being introduced to.

Puppy: The teacher will ensure that students feel comfortable in the classroom. The teacher will encourage students to try to answer questions and will support students giving incorrect answers.

Beach Ball: The teacher will require that students have an open mind when introducing complex numbers. The teacher will be sure that students have the opportunity to work with classmates to work though complex number equations.

Rationale: This lesson incorporates many different aspects that allow students of different learning styles to best benefit from the lesson. By keeping the lesson diverse the teacher is able to help the most amount of students succeed.

Standard 6 - Assessment. The teacher understands and uses multiple methods of assessment to engage learners in their on growth, to monitor learner progress, and to guide the teacher's and learner's decision making.

Formative:

Section I – checking for understanding strategy during instruction

Students will take part in example/non-example to come up with their own ideas for what is and is not a complex number. The teacher will also facilitate slap it to give students a fun way of practicing recognizing complex numbers.

Section II – timely feedback for products (self, peer, teacher)

Based on student responses from example/non-example the teacher will be able to assess how well students are understanding and give feedback to the students. Students will also communicate with the teacher to ensure that they are fully grasping the idea of imaginary numbers.

Summative:

Students will work either alone or with a partner to create a podcast, or a slideshow, to explain complex numbers, how they are derived, what their purpose is, how we represent them in an equation and their rules in an equation.

Rationale:

These assessments allow the teacher to be sure that students are truly understanding the material. The assessments still take into account all different types of learning styles and allows all students to showcase their knowledge.

Standard 7 - Planning Instruction. *The teacher plans instruction that supports every student in meeting rigorous learning goals by drawing upon knowledge of content areas, curriculum, cross-disciplinary skills, and pedagogy, as well as knowledge of learners and the community context.*

Content Knowledge:

Students will know equation, variable, coefficient, constant, distribute, roots, parabola, quadratic, factoring ax^2+bx+c , quadratic formula, order of operations, trajectory, profit, complex number, imaginary number

MLR or CCSS or NGSS**Common Core State Standards**

Content Area: Algebra

Grade Level: High school

Domain: Reasoning with Equations and Inequalities

Cluster: Solve equations and inequalities in one variable

Standard 4: Solve quadratic equations and in one variable.

b: Solve quadratic equations by inspection (e.g., for $x^2=49$), taking square roots, completing the square, the quadratic formula and factoring, as appropriate to the initial form of the equation. Recognize when the quadratic formula gives complex solutions and write them as $a+bi$ for real numbers a and b .

Facet: Explanation and Interpretation**Rationale:**

Students will be introduced to complex numbers and will required to understand what they are, how they work, and the rules that they follow.

Standard 8 - Instructional Strategies. *The teacher understands and uses a variety of instructional strategies to encourage learners to develop deep understanding of content areas and their connections, and to build skills to apply knowledge in meaningful ways.*

MI Strategies:

Verbal: Students will create t-charts to keep track of new ideas about complex numbers.

Logic: Students will need to think about what makes a number imaginary and how to distinguish them.

Visual: Students will be able to see examples and non-examples to help them identify their differences.

Musical: The teacher will play a song about complex numbers to help students better understand.

Kinesthetic: Students will play slap it to help students identify what is and is not an imaginary number.

Intrapersonal: Students will reflect on themselves and how they feel are understanding complex numbers.

Interpersonal: Students will take part in stand up, hand up, pair up, to work with others to create a deep understanding of complex numbers.

Naturalist: The teacher will give examples of complex numbers that relate to things in nature.

SAMR:

The slideshow or podcast that the students will be creating is at the augmentation level. They are at this level because a slide show allows for an automated presentation and a podcast allows students to record their thoughts and ideas on complex numbers.

Rationale:

Students will be able to showcase their comprehension of complex numbers and the algebraic rules that they follow. Students should take advantage of the many effects and tools that google presentation has to offer to make their presentations come alive. If students choose to do a podcast they should be sure that

NETS STANDARDS FOR TEACHERS

1. Facilitates and Inspire Student Learning and Creativity. Teachers use their knowledge of subject matter, teaching and learning, and technology to facilitate experiences that advance student learning, creativity, and innovation in both face-to-face and virtual environments.

- a. Promote, support, and model creative and innovative thinking and inventiveness
- b. Engage students in exploring real-world issues and solving authentic problems using digital tools and resources
- c. Promote student reflection using collaborative tools to reveal and clarify students' conceptual understanding and thinking, planning, and creative processes
- d. Model collaborative knowledge construction by engaging in learning with students, colleagues, and others in face-to-face and virtual environments

Rationale: a, c, d

Students will need to have an open mind when approaching the concept of complex numbers. Students will need to work with classmates to help each other with their understanding. The teacher will reflect and refine on their ideas of complex numbers.

2. Design and Develop Digital Age Learning Experiences and Assessments. Teachers design, develop, and evaluate authentic learning experiences and assessment incorporating contemporary tools and resources to maximize content learning in context and to develop knowledge, skills, and attitudes identified in the NETS-S.

- a. Design or adapt relevant learning experiences that incorporate digital tools and resources to promote student learning and creativity
- b. Develop technology-enriched learning environments that enable all students to pursue their individual curiosities and become active participants in setting their own educational goals, managing their own learning, and assessing their own progress
- c. Customize and personalize learning activities to address students' diverse learning styles, working strategies, and abilities using digital tools and resources
- d. Provide students with multiple and varied formative and summative assessments aligned with content and technology standards and use resulting data to inform learning and teaching

Rationale: a, b, c, d

Students will have the choice of creating a slideshow or a podcast. The teacher will encourage the students to think about complex numbers in their own way and will allow students to have their own ideas about complex numbers.